

Preliminary study of Purification for Livestock Wastewater of Immobilized Microcystis Aeruginosa

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Abstract

Immobilized microcystis aeruginosa was applied in purifying different concentration of livestock wastewater, of which removal ability to $\text{NH}_4^{+}\text{-N}$, TP and CODCr was investigated in this study. Sodium alginate (SA) and polyvinyl alcohol (PVA) were chosen as different entrapment agents. The results showed that with SA embedded in microcystis aeruginosa, the removal rate of $\text{NH}_4^{+}\text{-N}$, TP and CODCr to high-concentration wastewater reached 90.77%, 76.10%, 70.13% separately. While the removal efficiency went down along with low-concentration wastewater, which was 82.37% $\text{NH}_4^{+}\text{-N}$, 67.59% TP, 67.45% CODCr. PVA entrapped microcystis aeruginosa was inferior to SA, reaching removal of up to 77.41% $\text{NH}_4^{+}\text{-N}$, 69.02% TP, 55.07% CODCr for high-concentration wastewater. Treating low-concentration wastewater with PVA showed worst efficiency among the above agents. This study showed immobilization of microcystis aeruginosa in SA gel beads was more potential to serve as a treatment method for livestock wastewater.

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Keywords: Microcystis aeruginosa; Sodium alginate; Polyvinyl Alcohol; Livestock wastewater

1. Introduction

Livestock wastewater is highly concentrated organic matter, excessive suspended solids, large content of ammonia and phosphorus. All of its water quality indices exceed national discharge standards several times or even dozens of times. Untreated wastewater directly drained was a major contributor to environment pollution. It made water deteriorate, water system function lose and even endangering the potable water safety; made soil pore block, salinize and crust so that caused reduction and loss of agricultural production. As livestock breeding developing rapidly on a large scale, the pollution of it became the most important source besides industrial and domestic sewage, which affect normal life and productive activities and health of people [1].

Immobilized algae technology is a process dissociating cells are fixed on restricted space by chemical or physical means, which and used repeatedly with activity. In recent year scholars both at home and

abroad summarized its unique advantage application in wastewater treatment: denser cell, reaction rapidly, cell easy to harvest and high efficiency of removal. The method decreased the organic matter levels, eliminated pathogenic organisms and improved water quality, so that water can be reused or released into the environment with minimal consequences. It is an important biotechnology and had the potential as a treatment for wastewater [2-4].

Currently researches about immobilizing *microcystis aeruginosa* served to purify livestock waste for removing N, P nutrient were seldom reported. The study could offer guidance to the process in engineering.

2. Materials and methods

2.1 Microorganisms

Microcystis aeruginosa was purchased from Institute of Hydrobiology of Chinese academy of sciences as experimental product, which numbered FACHB 905.

2.2 Immobilization procedures

Sodium alginate (SA) and polyvinyl alcohol (PVA) were chosen as embedding agent. Inoculated sterilely in BG11 medium, *microcystis aeruginosa* was placed in irradiant incubator, parameters of which were $25 \pm 1^\circ\text{C}$, 2500lux light intensity lasting 12 hours and 12 hours dark. When *microcystis aeruginosa* grew stably via microscopic examination, it was concentrated by centrifugal effect twice and washed by sterile distilled water so that N and P nutrient element would be desorped. Then it and embedding agent were mixed according to a certain proportion and dripped into pre-cooling fixing solution, which contained saturated boric acid and 3% CaCl_2 , and formed gel beads. All of products were placed in refrigerator 24h with 4°C to enhance its hardness. Distilled water insteaded of *microcystis aeruginosa* liquid was immobilized as blank control group.

2.3 wastewater source and the determination of indicators

Livestock wastewater was taken from the places behind grills and Cyclic Activated Sludge System, both of which were units of the wastewater treatment station that served the scientific research base of Sichuan agricultural university. And the two kinds of wastewater were served separately as high concentration and low concentration wastewater, the quality of which was showed in table 1.

Table 1 Content of different index in high/low concentration livestock wastewater

index(mg/L)	NH_4^+-N	TP	COD_{Cr}
high concentration	54.18	15.10	613.82
low concentration	30.60	11.00	176.54

NH_4^+-N , TP and COD_{Cr} were determined according to the protocols in the Standard methods for the examination of water and wastewater (National Environmental Protection Agency, 2002).

2.4 Lab-scale equipment and operation mode

Filter out size particles with 3.5 mm in diameter and good spheroid. The particles were added by 8% of

the effective volume 1L in the lab-scale device (Figure 1).

Water treatment amount was 1L and hydraulic retention time was 6 days. Sample was determined for every 24h with index of $\text{NH}_4^+\text{-N}$, TP and COD_{Cr} .

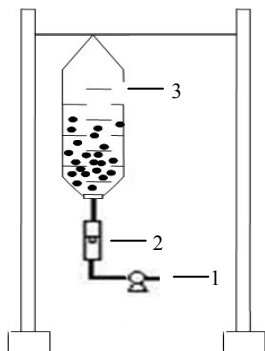


Figure 1 Schematic diagram of the experimental setup and control (1. air pump, 2. rotameter, 3. sampling port)

3. Results and discussion

3.1 Results of PVA and SA treating high concentration sewage

To define a practical, useful removal results between two embedding agents, it is essential to demonstrate water quality for several cycles. *Microcystis aeruginosa* continuously and significantly enhanced the growth of species when the gel beads also became bigger in the wastewater.

Removal efficiency of $\text{NH}_4^+\text{-N}$ and TP during one reaction period by immobilized *microcystis aeruginosa* was shown in Figure 2 A and B. In general, removal of high concentrations wastewater by immobilization with SA was superior to PVA. After a treating period, SA as embedding agent was better with average removal rate of 90.77% $\text{NH}_4^+\text{-N}$, 70.13% TP and 76.10% COD_{Cr} . While PVA was inferior with average removal rate of 77.41% $\text{NH}_4^+\text{-N}$, 69.02% TP, 55.07% COD_{Cr} .

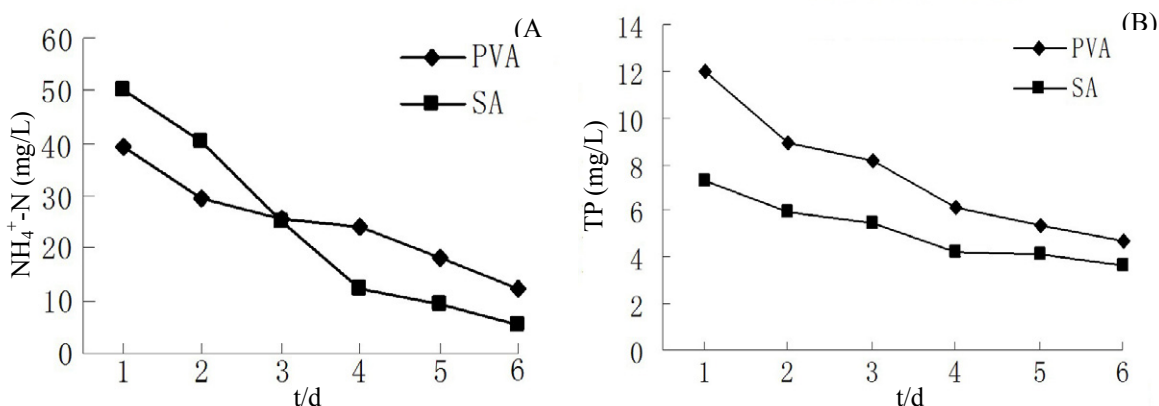


Figure 2 Removal rate of $\text{NH}_4^+\text{-N}$ (A) and TP (B) by immobilized *microcystis aeruginosa* for high concentration sewage

3.2 Results of PVA and SA treating low concentration sewage

Immobilization of *microcystis aeruginosa* with SA and PVA separately didn't enhance NH_4^+-N and TP removal for low concentration wastewater (Fig. 4 A and B). The end treatment effect showed that removal of high concentrations wastewater by immobilization with SA was still superior to PVA and average removal rate of NH_4^+-N , TP and COD_{Cr} was 82.37%, 67.45%; 67.59%, separately.

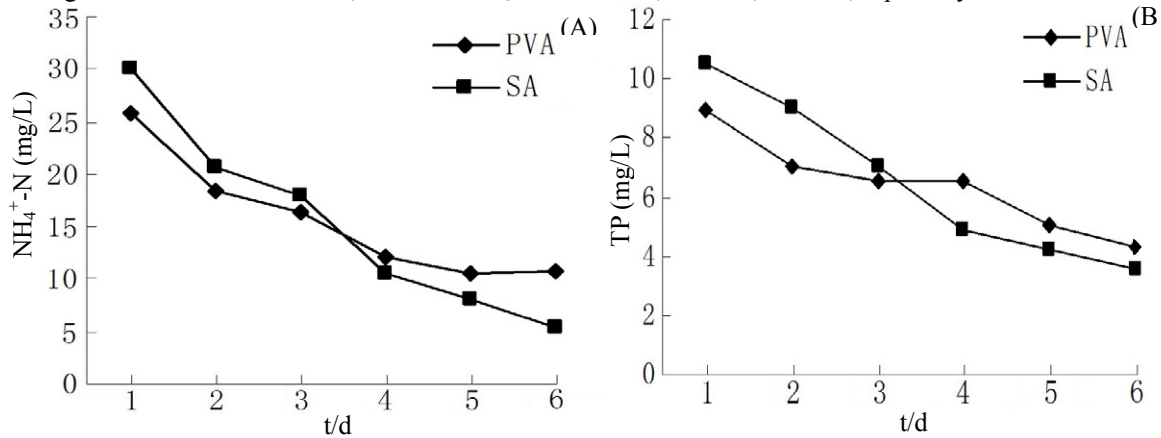


Figure 3 Removal rate of NH_4^+-N (A) and TP (B) by immobilized *microcystis aeruginosa* for low concentration sewage

From figure 2 and figure 3, after purification for six days sewage of ammonia nitrogen and phosphorus content decreased greatly. And significantly reduction of NH_4^+-N and TP occurred on 2nd to 4th day.

At the same time *microcystis aeruginosa* immobilized SA was always superior to PVA whatever it treated high or low concentration wastewater. On the other hand both immobilization of SA and PVA removed more amount of contamination in high concentration sewage than in low concentration. The probable reason was that high concentration nutrient N and P promoted the growth of *microcystis aeruginosa* in this research.

Currently, chemical precipitation with iron, alum, or lime was the main and widely used commercial processes for removing phosphorus from wastewater, achieving over 95% removal [6,7], and to a lesser extent biological treatment [8]. Practical biological methods with some bacterial species in laboratory tests were up to 90% removal of TP [9-11]. But other scholars researched that domestic sewage was treated by *microcystis aeruginosa* with SA and reacted for 6 days. In the end removal rate of ammonia nitrogen and phosphate achieved 100% [12].

3.3 Contrastive Analysis of Effect among SA, PVA and Blank Control

In this study the indigenous microflora of the wastewater was not analyzed in detail so blank control was set. There were a large number of bacteria and definitely a population of nitrifying bacteria in some wastewater samples. However, the blank control performed in this study did not yield significant removal of NH_4^+-N , TP and COD_{Cr} . Figure 4 A and B represented removal rate of 3 groups above. From each column value NH_4^+-N was easiest to wipe out and blank control performed similarly in two sewage of different concentration.

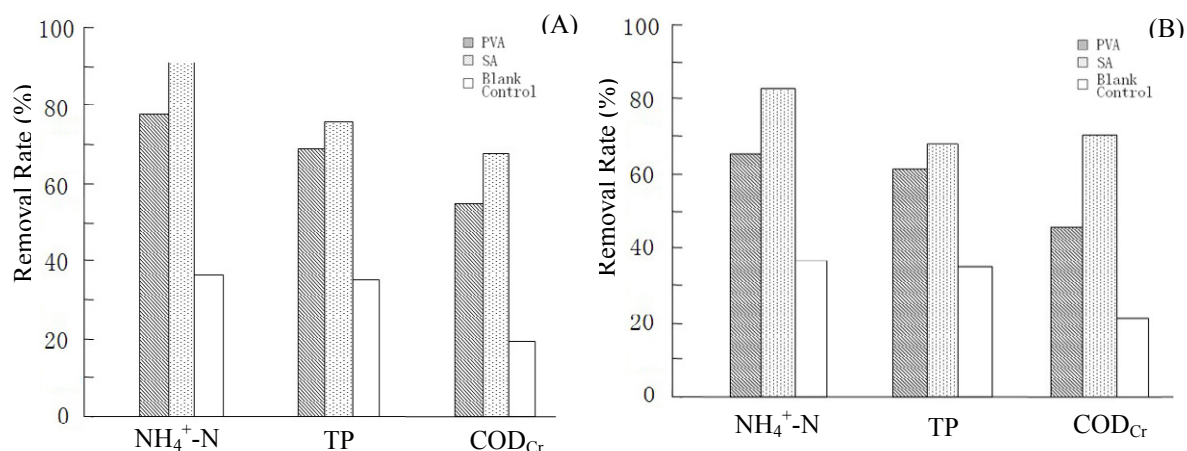


Figure 4 Removal rate of $\text{NH}_4^+\text{-N}$, TP and COD_{Cr} compared with PVA, SA and Blank Control for high (A) and low (B) concentration sewage

During whole experimentation *microcystis aeruginosa* entrapped by SA was always superior to PVA, let alone Blank control. The study attempted to analyze probable reasons—(1) permeability that determined the conditions of mass transfer between algal beads and contamination, (2) transparency that insured growth of *microcystis aeruginosa*, and (3) some interaction between *microcystis aeruginosa* and embedding agent.

4. Conclusions

This paper discussed *microcystis aeruginosa* entrapped by SA and PVA treating livestock wastewater, which demonstrated that the immobilization technology is capable of reducing nutrients (N and P) and organic matter. *Microcystis aeruginosa* with SA would be potential to be modified further.

5. Acknowledgements

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